US006948977B1

(12) **United States Patent**
Behrent

(10) **Patent No.: US 6,948,977 B1**
(45) **Date of Patent: Sep. 27, 2005**

(54) **CONNECTOR ASSEMBLY AND ASSEMBLY METHOD**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/911,790**

(22) Filed: **Aug. 5, 2004**

(51) **Int. Cl.**[7] **H01R 9/05**
(52) **U.S. Cl.** **439/581**; 439/607
(58) **Field of Search** 439/581, 63, 607–610

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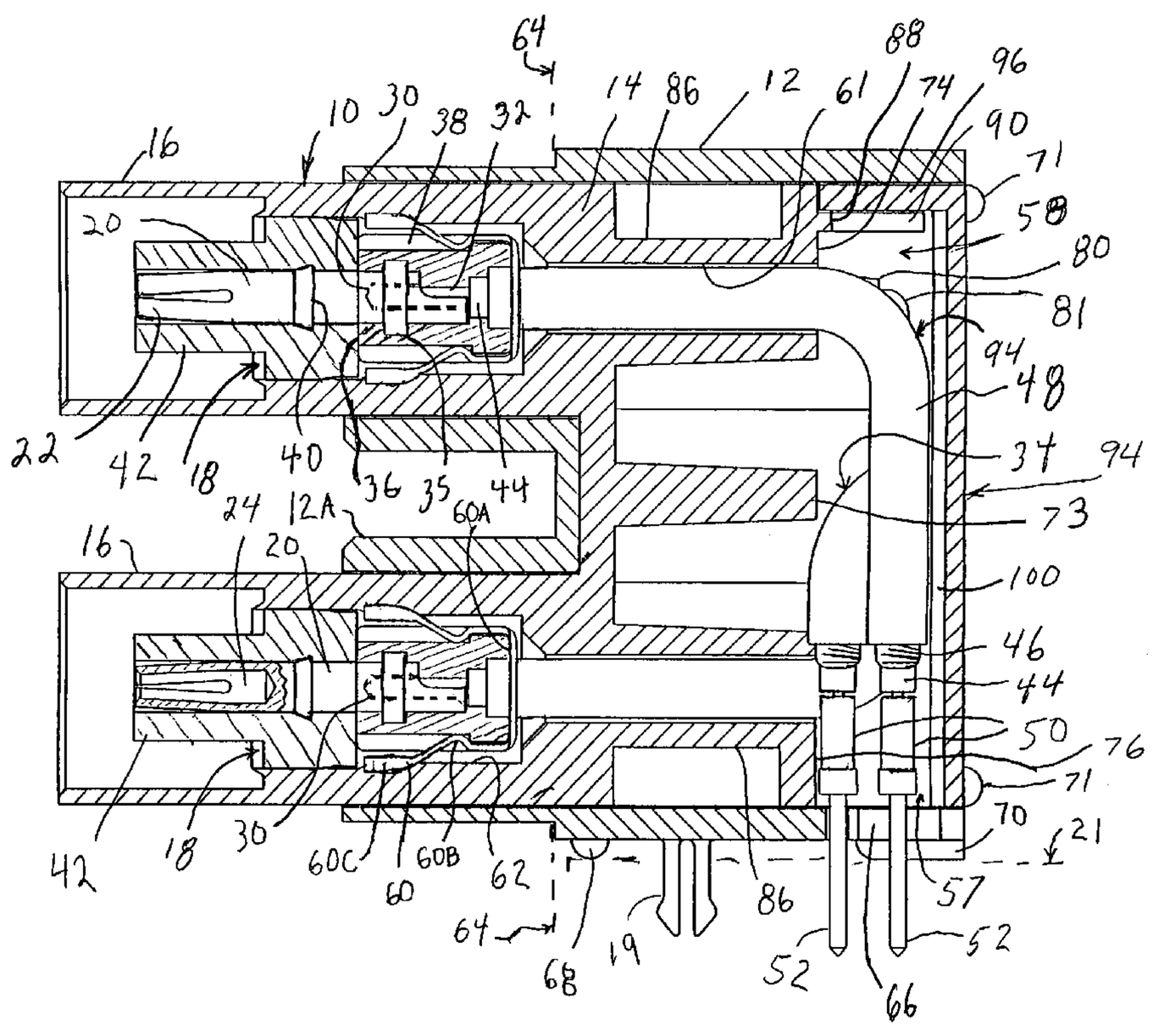
(57) **ABSTRACT**

A connector assembly that is mountable on a circuit board includes a casing having a metallic housing. The housing has at least one receptacle where a connecting element is mounted. A shielded cable connects between the connecting element and an interconnect that is attached to the casing. The interconnect has a plurality of contact elements adapted to contact the circuit board. The metallic housing can be fitted with any one of variously colored insulating shells either during manufacture or in the field. The shell can later be slidably removed and replaced, even after the housing was attached to a circuit board. The casings can have dovetail slots that mate with dovetail ridges on an insert used to attach the casings together.

23 Claims, 8 Drawing Sheets



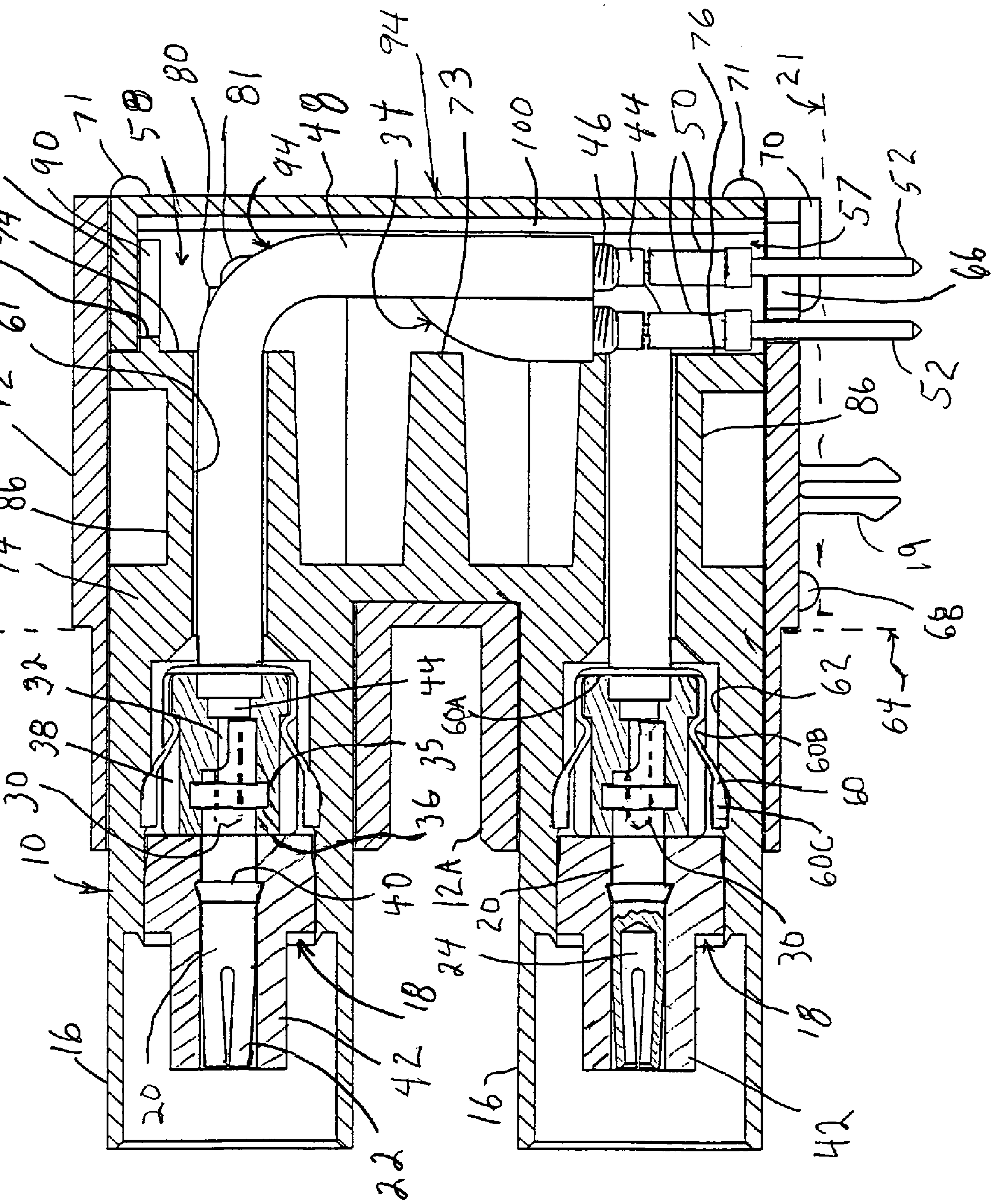


FIG 1

FIG. 3

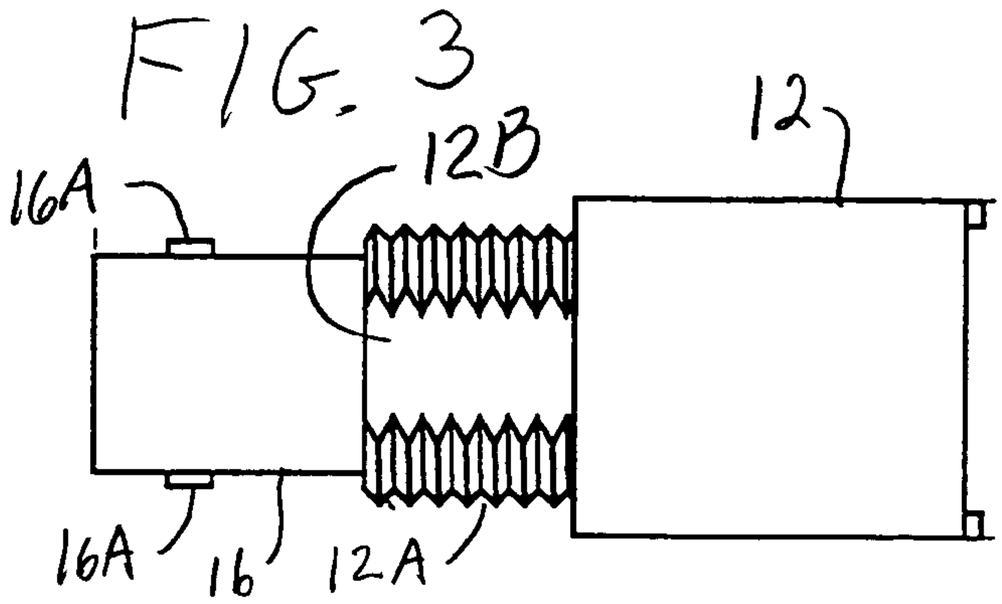


FIG. 4

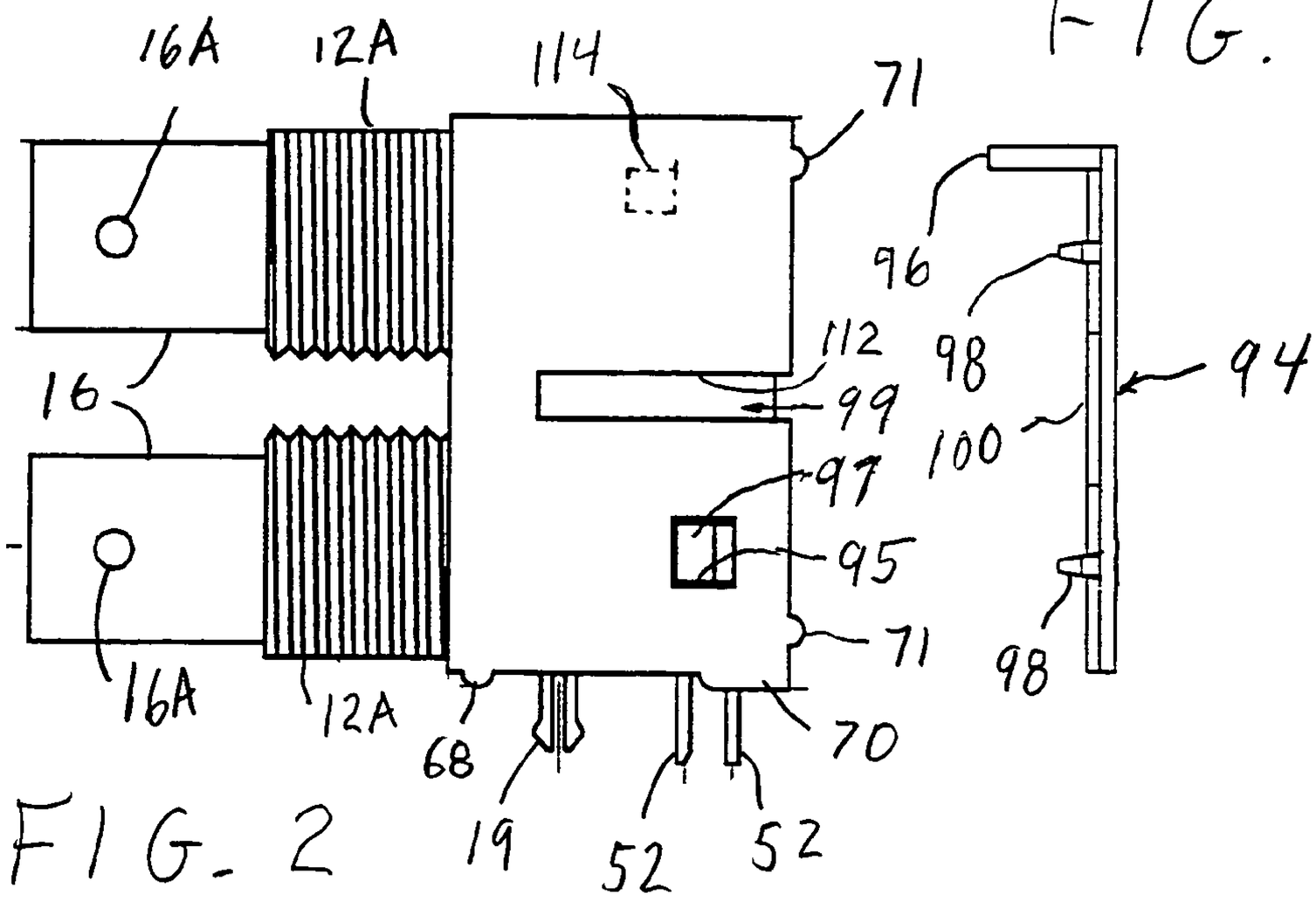


FIG. 2

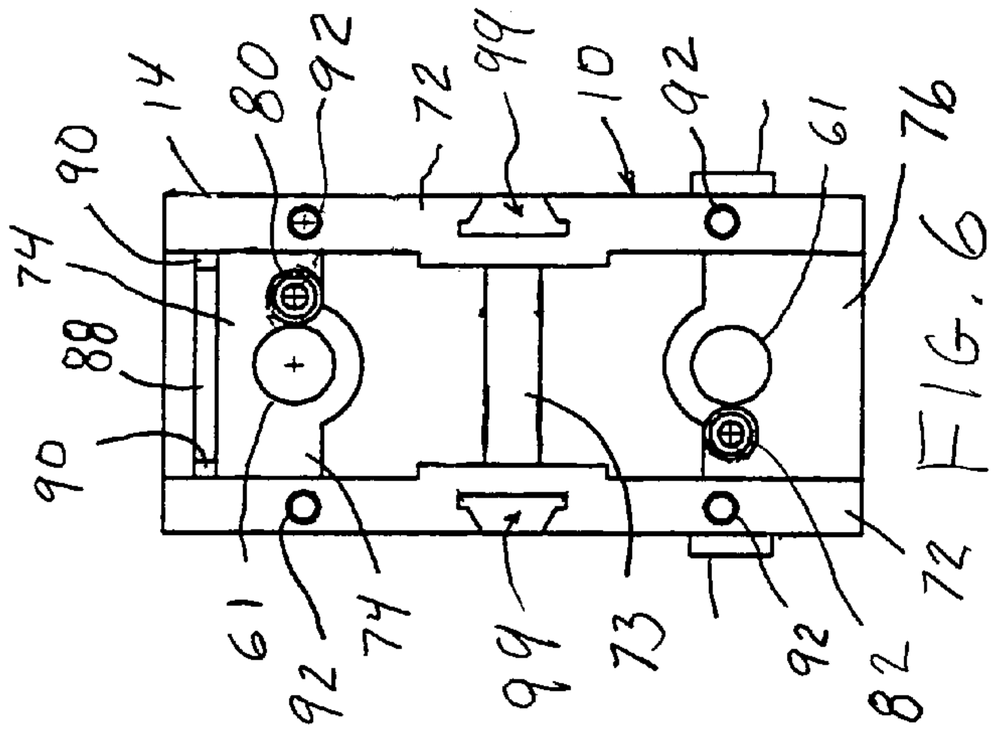


FIG. 6

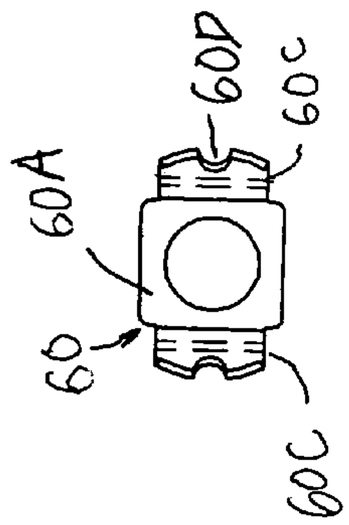


FIG. 8

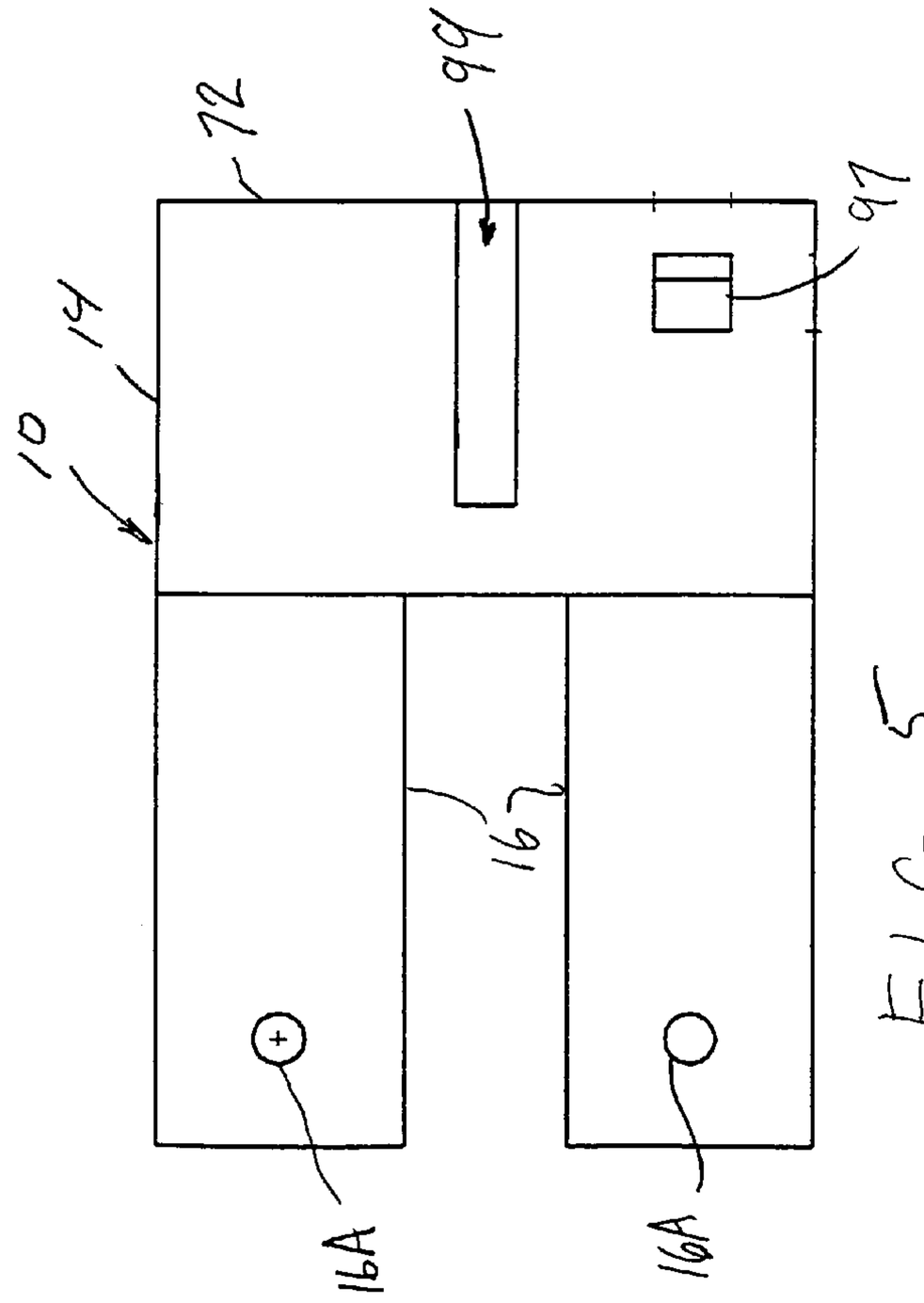


FIG. 5

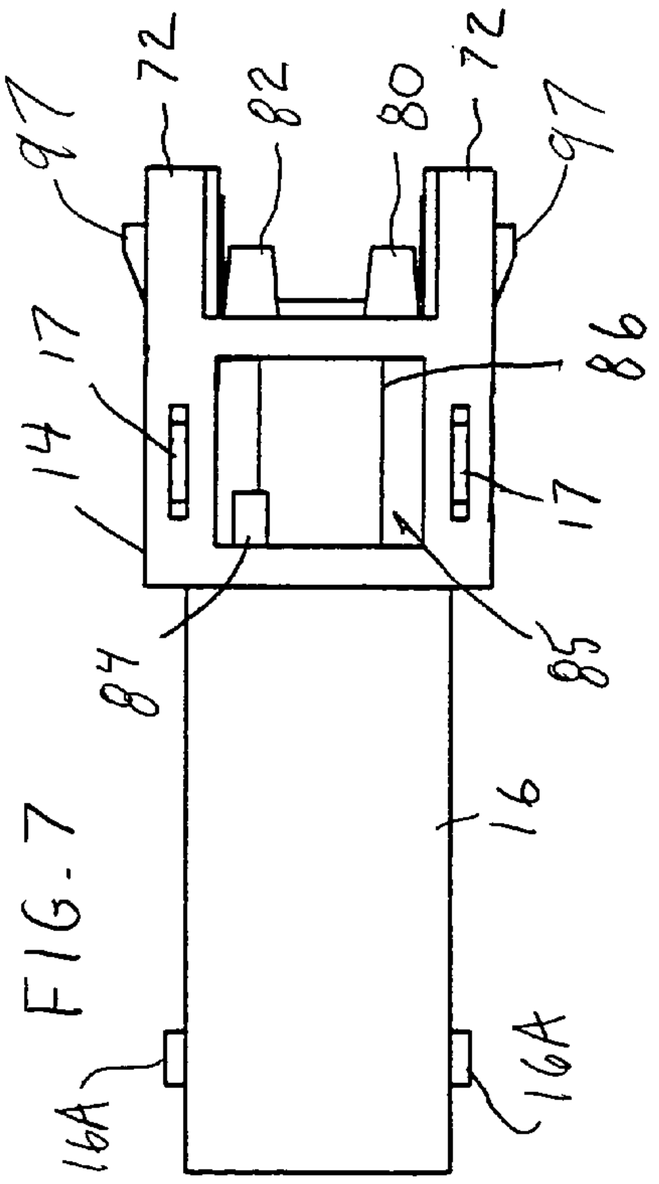


FIG. 7

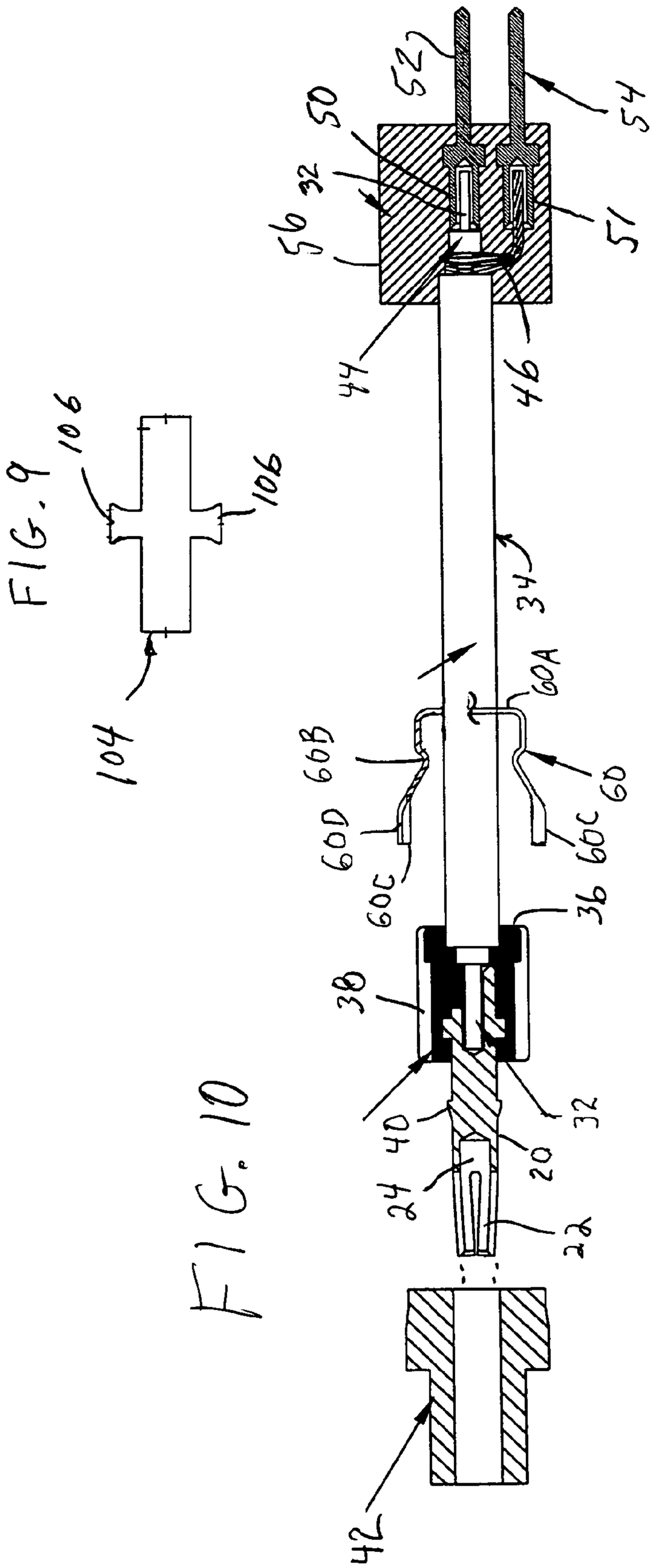
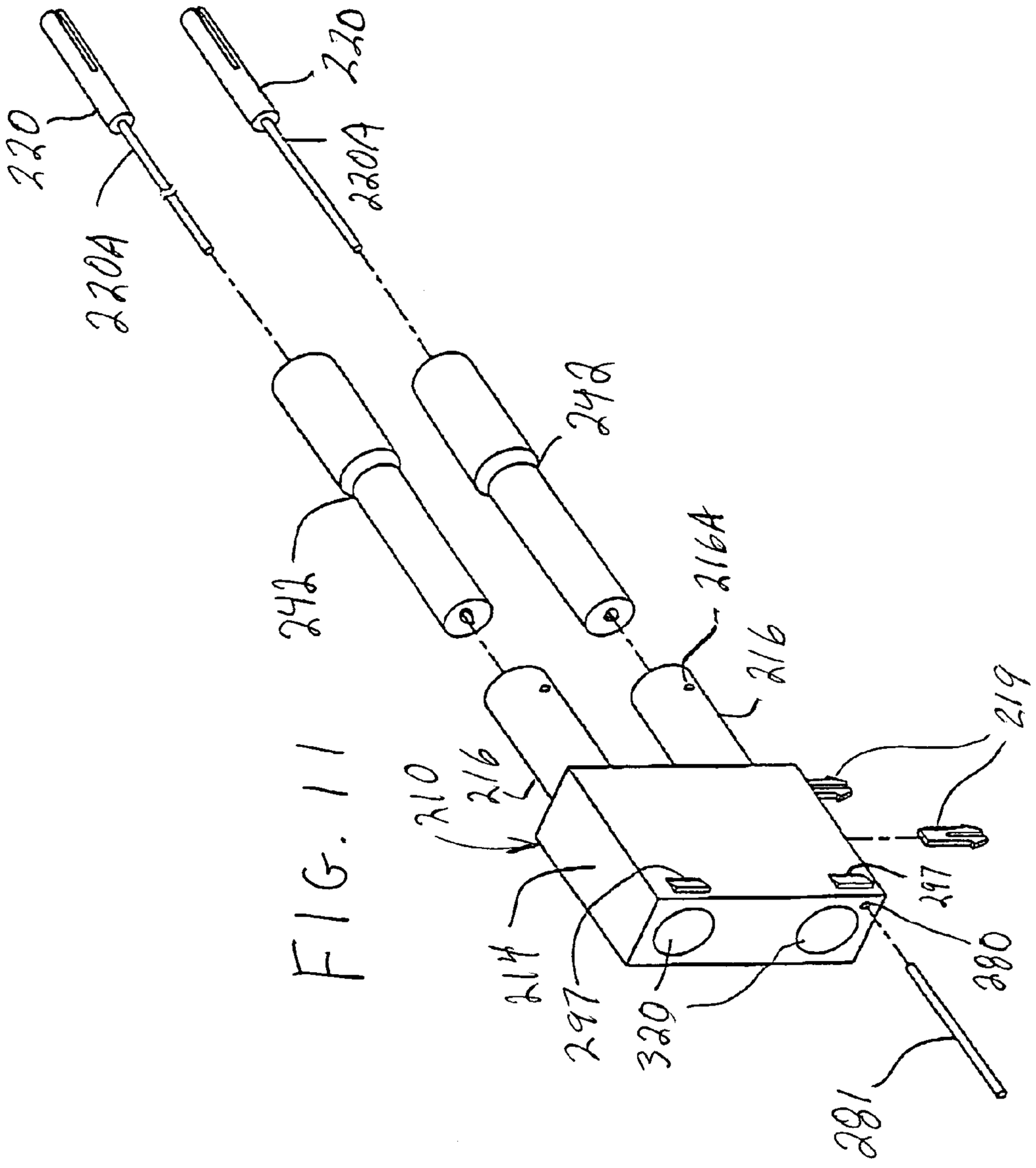

52
54
50
32
56
51
44
46
34
60A
60B
60D
60C
60
36
38
40
32
24
20
22
42
10

FIG. 9

106
106
104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297
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297
280
281
219

FIG. 11

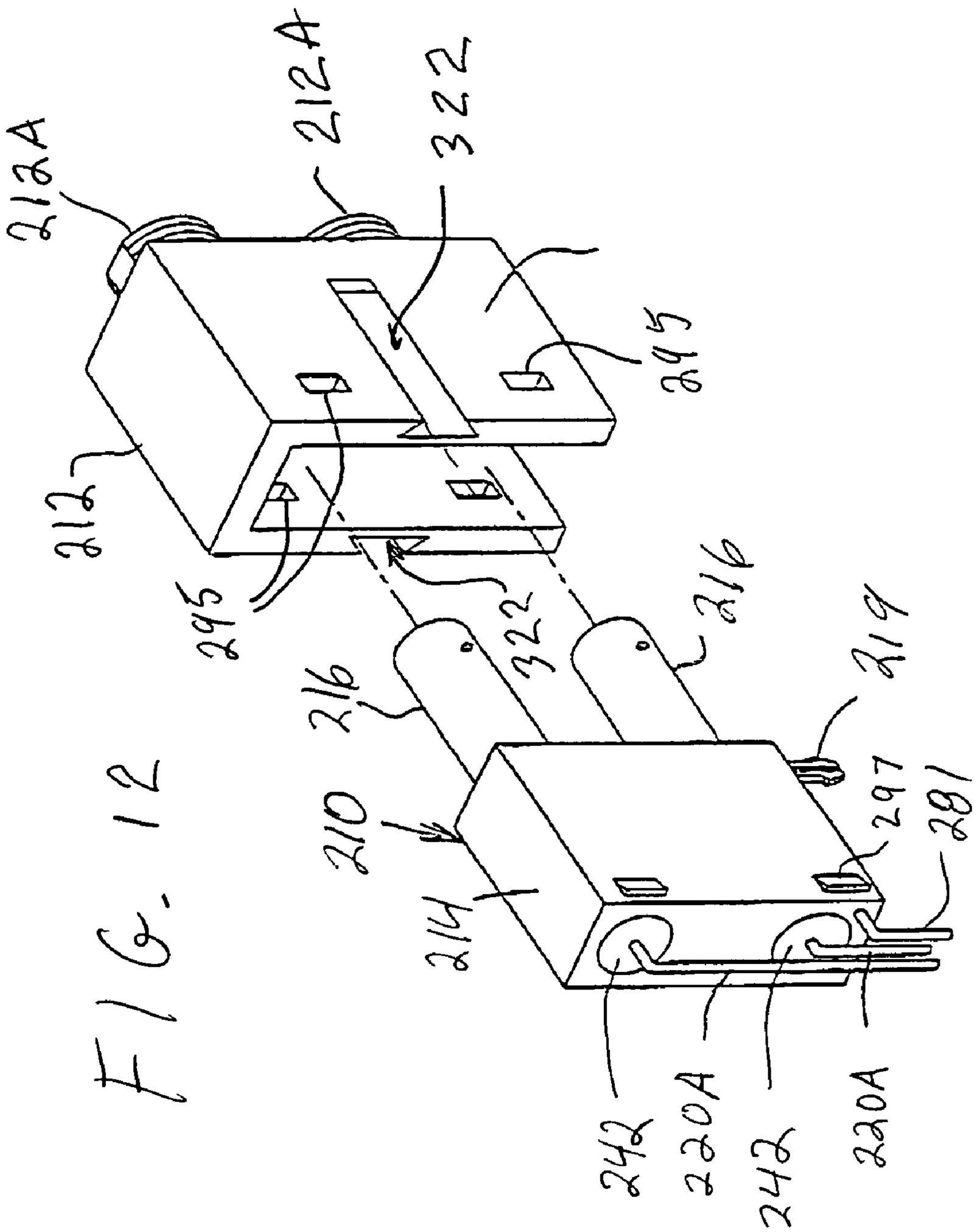

212A
212A
322
345
212
295
322
216
216
217
12
210
214
297
281
242
220A
242
220A

FIG. 6

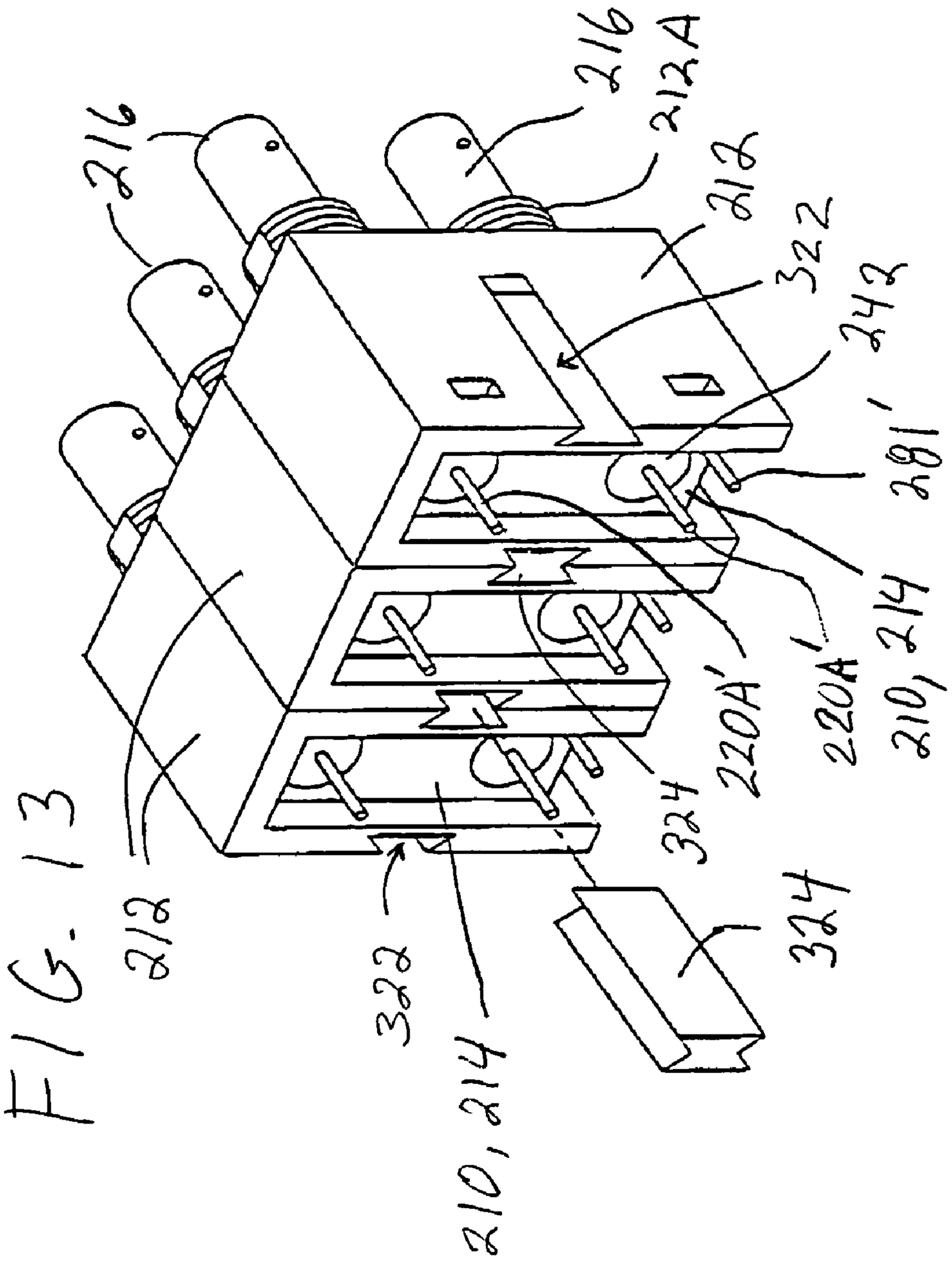
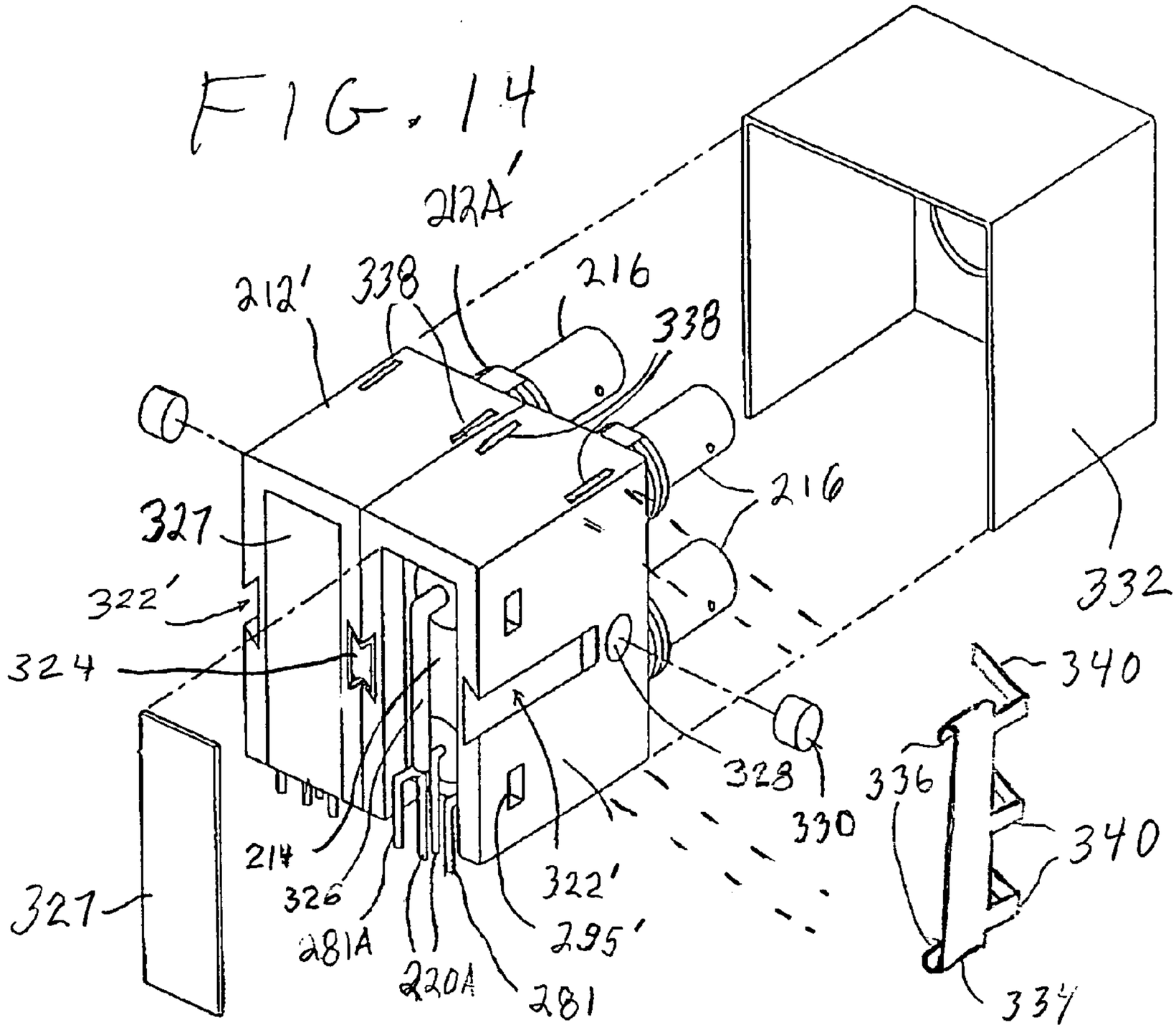

216
212A
212
322
242
281'
220A'
210, 214
324
13
FIG. 1

FIG. 14


212A'
212'
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216
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322'
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332
340
328
336
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214
326
322'
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281A
295'
220A
281
334

CONNECTOR ASSEMBLY AND ASSEMBLY METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to connector assemblies and assembly methods, and in particular, to devices that are adapted for various working environments.

2. Description of Related Art

Simple, reliable and effective connectors are needed in various electronic applications. Also, avoiding transmission losses and avoiding the receipt or transmission of electromagnetic interference (EMI) is important in many applications involving instrumentation, test equipment and high frequency applications handling signals such as video signals, shortwave signals, walkie-talkie signals, etc.

The problems with losses and EMI can be ameliorated with well-known shielding techniques, which include placing critical components inside a metal enclosure, and using shielded coaxial cables and shielded connectors that have a central lead surrounded by a cylindrical metal shell (for example, BNC or TNC connectors). In particular, coaxial shielded cables that have an impedance matching that of the source and destination tend to have little EMI problems or losses due to radiation, reflections or IR losses.

Applications employing multiple connectors can be especially vulnerable or prone to losses and EMI. Known compact connectors have placed a pair of connectors in a single assembly and routed wires attached to the rear of the connectors through a 90 degree turn in order to attach to contacts designed to connect to a printed circuit board. The radius of this 90 degree turn and the geometry of nearby metallic components greatly affect the losses and EMI effects, making manufacturing difficult.

Often, such connectors are mounted through a hole in a metal panel and held in place with a nut. In these cases it is often desirable to avoid multiple ground connections to such a panel in order to avoid ground loops that can be very sensitive to low-frequency interference from power mains. On the other hand, it is highly desirable to provide a high frequency ground on the panel in the vicinity of the connector to prevent the panel from acting like an antenna for the connector. For this reason, known connectors have employed a miniature capacitive element that connects between the connector's ground and the panel. For example, the capacitive element can be pressed against the connector by a metal strap or a shielding enclosure that reaches out to make contact with the back of the metal panel.

Accordingly, minimizing losses and EMI considerations place significant burdens on the manufacturers of electronic equipment who may need flexibility in arranging and efficiently placing connectors on printed circuit boards. These considerations also place significant burdens on the manufacturers of connectors who must be able to produce high-quality connectors efficiently and to develop standardized designs that can be adapted to various environments. Connector manufacturers would also like to work with castings and molds that can meet high-performance standards when necessary but can be configured to be cost-effective for less demanding environments.

In many electronic applications requiring multiple connectors, these connectors must be color-coded to help the end-users. Stocking a large number of variously colored connectors can be inefficient for manufacturers. Also, during manufacture or repair a wrongly colored connector may be inadvertently soldered onto a circuit board, which greatly increases the time required to complete manufacturing or repair.

In FIG. 2a of U.S. Pat. No. 6,042,394 the shield of cables 18 are shown adjacent to the shields 31 around each of the center contacts 15. The specification says (column 3, lines 57–58) the cables are intended to "meet impedance requirements or to avoid deteriorating reflections," without describing how or if the shields are connected.

In U.S. Pat. No. 6,679,728 a pair of mini BNC connectors are formed with a common metal case 10 having a connected pair of shielding cylinders 101 and 102. Casing 10 is described as having insert legs 107.

In one embodiment of U.S. Pat. No. 5,169,343 the outer contact parts of a column of coaxial connectors are connected to shielding cases 22 and 23. Also, the rear wall 33 of casing 23 serves as the shield for two separate inner contacts in the column of coaxial connectors. Each of the casings 22 and 23 have a separate pair of mounting pins 24. In the embodiment of FIGS. 6 and 7 a column of coaxial connectors has a common shield formed of a single metal block 49/50.

In U.S. Pat. No. 5,730,621 a pair of BNC or TNC connectors are mounted in parallel in a plastic block containing shunting capacitors 5 and 5'.

In U.S. Patent Application Publication No. 2003/0073328 a motherboard can be connected to a daughterboard by an interconnection system that has a number of twin lead shielded cables. Each of the signal leads of each pair is fitted with a spring contact that engages contact pads on the circuit boards. While FIG. 1A shows a relatively open structure, the cables can be packaged inside a unitary housing as shown in FIG. 13A.

In U.S. Pat. No. 6,234,834 connector bodies 21, 22 and 23 are stacked and held together with dovetails 224 and 232. Each of the connector bodies have four contacts in each of the three contact groups 3. In addition, a common ground is provided by contact 4 which has three arms 44 that are inserted between the contacts of each of the three groups 3. The stack is mounted inside a conductive shield 1. See also U.S. Pat. No. 6,508,665.

In U.S. Pat. No. 5,863,222 a pair of connectors are mounted on a common header 20, each having a number of contact pins 21. The back of both connectors is shielded by a grounded plate 30 that is connected to a circuit board by the tabs 38.

In U.S. Pat. No. 4,806,107 a high frequency backplane connector has several rows of connectors separated by elements 41, 42. The connectors are mounted in housing 50 and flexible circuit board 27 inside the housing connects these connectors to the pins 61–63 that in turn connect to a printed circuit board.

In FIG. 1A of U.S. Pat. No. 6,244,896 a row of RJ connectors are mounted inside a common shield 2 that has ground tab 15 for engaging shields of RJ plugs. In the embodiment of FIG. 4 an upper and lower row of RJ connectors are stacked together.

See also U.S. Pat. Nos. 5,190,461; 5,085,590; 5,921,814; 6,626,700; and 6,022,245.

SUMMARY OF THE INVENTION

In accordance with the illustrative embodiments demonstrating features and advantages of the present invention, there is provided a connector assembly having a casing with a metallic housing that has at least one receptacle. The casing is adapted for mounting on a circuit board. Also

included is at least one connecting element mounted at the at least one receptacle. The assembly also has an interconnect attached to the casing. The interconnect has a plurality of contact elements adapted to contact the circuit board. Also included is a shielded cable connected between the connecting element and the interconnect.

In accordance with another aspect of the invention a connector assembly is provided with a metallic housing adapted for mounting on a circuit board. The metallic housing has at least one receptacle. Also included is an insulating shell sized to fit around the metallic housing. The insulating shell is slidably removable from the metallic housing. The assembly also has at least one connecting element mounted at the at least one receptacle. Also included is an interconnect that is attached to the metallic housing and that has a plurality of contact elements adapted to contact the circuit board. At least one of the contact elements is coupled to the connecting element.

In accordance with another yet aspect of the invention a connector assembly is provided with a pair of metallic housings each adapted for mounting on a circuit board and each having at least one receptacle. The metallic housings each have a dovetail slot. Also included are connecting elements mounted at the at least one receptacle of each of the metallic housings. The assembly also includes an insert and a pair of interconnects each attached to a corresponding one of the housings. Each of the interconnects has a plurality of contact elements, at least one of them coupled to the connecting element of a corresponding one of the housings. The contact elements are attached to the housings and are adapted to contact the circuit board. The insert has on opposite sides dovetail ridges sized to slide into the dovetail slots of the metallic housings. Thus, by means of the dovetail ridges on the insert the housings can be attached together.

In accordance with another yet aspect of the invention a connector assembly method is provided employing a plurality of variously colored insulating shells and a metallic housing having a receptacle and contact elements. The method includes the step of bringing the metallic housing to the vicinity of a circuit board. Another step is selecting one of the variously colored insulating shells and fitting it around the metallic housing. The method also includes the step of connecting the contact elements to the circuit board.

By employing assemblies and assembly methods of the foregoing type an improved connection technique is achieved. In a preferred embodiment multiple connectors are provided on a single housing formed from a single metal casting.

For example, the cylindrical metal sleeves of a pair of BNC connectors are integrally cast with a common back frame that has an open rear recess. Thin tubular sockets with springy fingers are mounted in the cylindrical metal sleeves. These thin tubular sockets are surrounded with a tubular insulator, and are fastened in place by an annular spring clip.

The proximal ends of the tubular sockets are connected to the center leads of shielded coaxial cables. These coaxial cables are routed through a recess in the back of the metal housing to an interconnect in the form of a plastic carrier holding a number of pins designed to be soldered into a printed circuit board. In particular, the center lead and the shield of the coaxial cables are separately connected to individual pins of the interconnect. The coaxial cables can be easily installed and still maintain excellent loss and EMI characteristics. In particular, the coaxial cables can be routed through the recess without the need to place them in an exact position or to maintain a precise radius of curvature. High immunity to EMI can be achieved by covering the recess containing the coaxial cables with a metal backplate.

On the other hand, the foregoing metal housing can be fitted with ordinary wire leads instead of coaxial cables for applications that do not have strict requirements on avoiding losses or EMI.

The preferred metal housing can be adapted for an even greater variety of applications by casting it with a dovetail groove on opposite sides. Then multiple housings can be ganged together with an interconnecting insert having an opposing pair of dovetail ridges designed to fit into the dovetail grooves on the metal housings. The preferred insert is a plastic plate molded with dovetail ridges on opposite sides.

Preferably, a color-coded plastic shell would be slid over the metal housing either during manufacture or at the installation site. The shells are easily replaced in the event the wrong color coding was selected. Also, the plastic shell can be chosen to accommodate embodiments where the circuit board contacts emerge to the rear or to the side. In addition the shells can be formed with openings designed to accommodate capacitive elements or the above mentioned dovetail slots. These capacitive elements are preferably held in place by a metal bracket or enclosure that extends to touch the back of a metal panel to which the connector may be attached.

BRIEF DESCRIPTION OF THE DRAWINGS

The above brief description as well as other objects, features and advantages of the present invention will be more fully appreciated by reference to the following detailed description of presently preferred but nonetheless illustrative embodiments in accordance with the present invention when taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a side, cross-sectional view of a connector assembly in accordance with principles of the present invention;

FIG. **2** is a side view of the assembly of FIG. **1**;

FIG. **3** is a top view of the assembly of FIG. **2**;

FIG. **4** is a side view of the metal backplate in the assembly of FIG. **1**;

FIG. **5** is an side view of the metallic housing of FIG. **1**;

FIG. **6** is a rear view of the housing of FIG. **5**;

FIG. **7** is a bottom view of the housing of FIG. **5**;

FIG. **8** is an front view of the annular clip of FIG. **1**;

FIG. **9** is an end view of an insert that may be used to connect the housings of FIG. **1** together in groups;

FIG. **10** is an assembly diagram associated with the components of FIG. **1**;

FIG. **11** is an exploded, perspective view of an assembly that is an alternate to that of FIG. **1** and which is fitted with alternate leads;

FIG. **12** is an exploded perspective view of the assembly of FIG. **11** with an insulating shell that is an alternate to that of FIG. **1**;

FIG. **13** is an exploded perspective view of a trio of matching assemblies as per FIG. **12** that are attached together with a dovetailed insert; and

FIG. **14** is an exploded perspective view of a pair of matching assemblies as per FIG. **12** that are attached together and fitted with additional components.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. **1–8**, a connector assembly is shown as a casing having a metallic housing **10** with an insulating shell **12**. The housing **10** is a zinc plated steel die casting with a rear rectangular block **14** and a pair of parallel cylindrical metal sleeves **16**, encompassing openings **18**, herein referred to as receptacles. Sleeves **16** are each shown with an opposing pair of stubs **16**A that are typically employed in BNC connectors, although it will be appreciated that the principles of the present invention can be applied to other types of connectors. Embedded in slots **17** in housing **10** are external grounding tabs **19**, shown herein as bifurcated stakes designed to snap into a hole in a printed circuit board **21** (shown in phantom).

Mounted in receptacles **18** are pair of connecting elements **20** having at their distal ends four springy, longitudinal fingers **22** distributed around a cavity **24**. The proximal ends of connecting elements **20** each have a wire hole **30**. The central lead **32** of shielded cable **34** is soldered into wire hole **30**. Molded around the junction between element **20** and cable **34** and locking onto flange **35** of element **22** is an insulating knob **36**, which has a pair of diametrically opposed, stepped grooves **38**.

Elements **20** have an annular barb **40** that allows insulating collars **42** to be pressed onto elements **20** into abutment with knobs **36**, but not withdrawn in the opposite direction. The collars **42** are made with a uniform internal diameter but the proximal end of the collar has an outside diameter that is greater than the outside diameter of the distal end.

The connecting elements **20** can be held in place with annular clips **60** having a flat transverse annulus **60**A with a pair of longitudinally extending arms having a section with an inward bight **60** that leads to a cylindrical section **60**C split with bifurcations **60**D. After clip **60** is placed around cable **34** and snapped into stepped grooves **38** of knob **36**, cables **34** can be inserted through the receptacles **18** and the cable tunnels **61** to allow the bifurcations **60**D to ride inwardly on one of the four splines **62** deep within receptacle **18**. The bifurcations **60**D are angled to allow insertion but resist withdrawal. The cables **34** may be previously fitted with contact elements **52**/**54** if they are small enough, otherwise these elements are installed after the cables routed through the tunnels **61**. In this embodiment the upper one of the cables **34** makes a simple downward turn, while the lower cable makes a more complicated pigtail turn.

Shielded cables **34** are conventional coaxial cables having the previously mentioned central leads **32** encircled by an insulating sleeve **44**, which is in turn surrounded by a coaxial shield **46** in the form of a copper braid covered by insulation **48**. In one embodiment the shielded cables **34** were able to carry signals of 2 GHz or more, and suitably rated for 3 Ghz signals.

The central leads **32** at the end of cables **34** opposite connecting elements are soldered into the hollow cylindrical barrels **50** that are integral with pins **52**, which are herein referred to as contact elements. As shown in FIG. **10**, braid **46** is also soldered into the hollow barrel **51** of the contact elements **54**, which are identical to elements **50**/**52**.

Contact elements **52** and **54** are shown in FIG. **10** molded into a carrier **56** and the elements inside carrier **56** are referred to herein as an interconnect. In some embodiments carrier **56** may be a plastic grid with apertures sized to hold elements **52** and **54**. In the embodiment of FIG. **1** the contact elements forming an interconnect (only elements **52** are visible) are not held in the hollow **57** by a separate carrier but are held in place by virtue of the stiffness of cables **34**. In such an embodiment guideways or guiding ridges (not shown) in the assembly may keep the cables **34** and their braids **46** in approximately the correct position. Alternatively, the recess **58** containing cables **34** can be filled with a potting compound to hold in place the cables **34** and the contact elements **52**/**54** attached thereto.

Previously mentioned insulating shell **12** closely embraces the top, sides and bottom of the metallic housing **14** and its threaded barrels **12**A. Barrels **12**A of shell **12** cover about half the length of the metal sleeves **16** and are threaded so the assembly can be secured in a hole in a conductive panel **64** (shown in phantom) with a nut or other fastener (not shown). Shell **12** has a number of subjacent slots **66** giving clearance so that the shell can be slid onto or off the housing **14** without interference from pins **52**/**54** or stake **19**.

A pair of front feet **68** at the front corners of shell **12** and a pair of rear feet **70** at the rear corners raise the assembly off circuit board **21**, which can be important for flushing away residues that might otherwise accumulate under the assembly. As explained further hereinafter, this assembly can be assembled in such a way that the tubular sleeves **16** are perpendicular to the printed circuit board **21**, in which case feet **71** on shell **12** perform a similar function of lifting the assembly off the circuit board.

The block portion **14** of housing **10** has a cross wall **73** extending between a pair of parallel side walls **72** that flank an upper plateau **74** and lower plateau **76**, which plateaus are pierced by previously mentioned tunnels **61**. As shown in FIG. **6**, a tubular portal **80** to the right of tunnel **61** on upper plateau **74** and tubular portal **82** to the left of tunnel **61** on plateau **76** constitute the openings to grounding holes that extends through the bulk of block portion **14**.

As shown in FIG. **7** the far end of the grounding hole of portal **82** reaches a side aperture **84** that opens into a recess **85** of block **14** having a cylindrical hump **86** containing previously mentioned tunnel **61**. Another similar opening exists on the opposite side of block **14** for the grounding hole of portal **80**. As described further hereinafter, in some embodiments a lead can be inserted into the grounding hole of portal **82** (and portal **80**) and routed to or through opening **84** where the lead can be bent or soldered to hold it in place. In fact, a lead **81** is shown in FIG. **1** projecting from portal **80**, and making a downward turn in order to attach along with pins **52** into the printed circuit board **21**.

A ridge **88** (FIG. **6**) extending across plateau **74** meets a spaced pair of parallel ridges **90** on the insides of walls **72**. The overhang **96** (FIG. **4**) of metallic backplate **94** will rest on ridges **88** and **90**. Also the pins **98** on the inside of backplate **94** are inserted in the holes **92** of walls **72**. In addition, the inside face of backplate **94** has a raised region **100** with an outline designed to fit snugly between walls **72**.

Starting in an edge of walls **72** and running most of the length of housing block **14** are a pair of dovetail slots **99**. In FIG. **9** insert **104** is shown having a center plate with a pair of opposing dovetail ridges **106** that give the insert a cruciform cross-section. The insert **104** is designed so that one of its dovetail ridges **106** can fit snugly into one of the dovetail slots **99** on housing block **14**. As described further hereinafter, the other dovetail ridge on insert **104** can slide into a dovetail slot on another assembly similar to the one shown in FIG. **1**. Therefore, multiple assemblies can be stacked or ganged together.

Instead of the illustrated dovetailed inserts, alternative inserts may have ridges with a cross-section having a keyhole shape, hooked shape, etc. Also, the ridge need not

be one continuous element but may be a number of spaced elements. Moreover, the ridge may snap into mating groove instead of sliding. In addition, some connector assemblies may be formed with a ridge on one side and a slot on the other side so that they can be attached together without the need for a separate insert.

Located near the lower rear corner on opposite sides of housing block **14** are locking stubs **97**, which are tapered so that when shell **12** is slid over housing **10** stubs **97** can enter and lock into apertures **95** in shell **12**. Shell **12** also has a pair of slots **112** allowing easy access to the dovetail slot **99** in housing block **14**. Shell **12** also has an optional aperture **114** designed to hold a capacitive element that will be described presently.

Referring to the alternate embodiment of FIG. **11**, components corresponding to those previously illustrated in FIG. **1** will have the same reference numeral but increased by 200. In particular, metallic housing **210** has a rectangular block **214** supporting an integral pair of sleeves **216** with locking stubs **216**A. The interiors of sleeves **216** communicate to the two openings **320** in the rear of block **214**. Attached to the bottom of housing block **214** are a pair of grounding tabs **219** designed to lock into holes on a printed circuit board (not shown). Locking stub **297** at the four back corners of housing block **214** serve the same function as the previously mentioned stubs (stubs **97** of FIG. **5**). Housing block **214** also has a wire portal **280** for receiving a grounding wire **281**.

A pair of plastic insulating collars **242** are designed to fit into sleeves **216** and extend back to the openings **320** in housing block **214**. Collars **242** have coaxial bores designed to receive connecting elements **220**, which are very similar to the previously described connecting elements (elements **20** of FIG. **1**), except that the rear portions of elements **220** have a simple integral wire lead **220**A.

Referring to FIG. **12**, metallic housing **210** is shown assembled with insulating collars **242** mounted inside sleeves **216** and housing block **214**. Previously mentioned wire leads **220**A and grounding wire **281** are bent down and trimmed to extend below the bottom of housing block **214** an amount sufficient to allow connection to a printed circuit board (not shown).

An insulating shell **212** with a pair of threaded barrels **212**A is designed to slide over metallic housing **210** and lock into place when stubs **297** snap into holes **295**. In this embodiment there are no dovetail slots on housing block **214**. Instead, a pair of dovetail slots **322** serving the same purpose are formed on opposite sides of shell **212**.

Referring to FIG. **13**, three identical sets of the components of FIG. **12** are shown assembled but with differently configured wire leads **220**A' and grounding wire **281**'. Specifically, leads **220**A' and wire **281**' are not bent and extend rearwardly an amount sufficient to allow connection to a printed circuit (not shown). In contrast to the embodiment of FIG. **12**, the connector sleeves **216** will be oriented perpendicular to the circuit board.

The three illustrated identical assemblies are attached together with inserts **324** having a "butterfly" cross-section, that is, an opposing pair of dovetail ridges designed to fit into the dovetail slots **322** on the sides of shells **212**.

Referring to FIG. **14**, the components shown in FIG. **12** have been modified, paired, and attached together as a pair by means of previously mentioned insert **324**. In this embodiment, one of the leads **220**A has been fitted with an insulating sleeve **326**. Also, another grounding wire **281**A has been attached to housing block **214** to supplement the other grounding wire **281**. A metallic backplate **342** sized to fit inside the rear opening a shell **212**' provides enhanced shielding.

Also, in comparison to the previously mentioned shell (shell **212** of FIGS. **12** and **13**) an aperture **328** has been formed in the side of shell **212**' to receive a capacitive element **330**. When slid over sleeves **216** and shell **212**', the sheet metal structure **332** is capacitively coupled through element **330** to the metallic housing block **214**. Thus, if the assembly is then fastened onto a metal panel (not shown) by threading a nut onto threaded sleeves **212**A', the metal panel will touch structure **332** and thus have a local high frequency ground connection through capacitive element **330** through housing block **214** and ground wires **281** and **281**A.

In some embodiments structure **332** may be replaced with a metal strap structure **334** having lips **336** designed to snap into slots **338** on the top and bottom of shell **212**'. Strap structure **334** also has a trio of springy arms **340** that reach around to the front of shell **212**' in order to electrically contact a metal panel (not shown) to which the assembly may be attached as described before.

To facilitate an understanding of the principles associated with the foregoing apparatus, the assembly and operation of the connector of FIGS. **1–9** will be briefly described, although it will be appreciated that the description for the other embodiments will be similar.

The cable **34** can be soldered to connecting element **20** before forming knob **36** around the soldered joint, as shown in FIG. **10**. Thereafter, insulating collar **42** can be forced onto connecting element **20**, moving into abutment with knob **36** as annular ridge **40** is wedged and locked into the collar. The annular clip **60** can be slid onto cable **34** and pushed over knob **36** until bights **60**B snap into slots **38**. In some embodiments metal clip **60** will contact braided shield **46** of cable **34**, in which case the distal end of the shield will be grounded to the housing **10**, although in most embodiments such a grounding connection will not be made through clip **60**. Cable **34** can then be inserted through receptacle **18** (FIG. **1**) and through tunnel **61** until clip **60** reaches the illustrated position wherein bifurcated arm portion **60**C is wedged in place deep within receptacle **18**.

The unconnected ends of the center lead **32** and braid **46** of cable **34** can be soldered into the barrels **50** and **51** of the contact elements **52** and **54**, as shown in FIG. **10**. If desired, carrier **56** can be molded around these contact elements, although in some embodiments these contact elements will maintain a desired position due to the restricted space existing in recess **58** (FIG. **1**).

In addition, ground wires can be inserted into portals **80** and **82**. The tip of the inserted wire can be held in place by being bent or soldered through an associated opening, such as opening **84**. The installed ground wires can be bent down.

Thereafter, shell **12** can be slid over metal sleeves **16** and into the position shown in FIG. **1**. Slots **66** on the bottom of shell **12** avoid interference with pins **52** and **54**, wire **81** and stake **19**. The back of shell **12** can be closed by pressing cover **94** in place so that overhang **96** rests on ridges **88** and **90**, and pins **98** fit into holes **92**.

The connector assembly can be initially secured to the printed circuit board **21** by pressing stake **19** through a hole in the circuit board **21**. Simultaneously, pins **52** and **54** and the previously mentioned ground wires (for example ground wire **81**) will also be inserted through corresponding holes in the circuit board **21**. These components inserted into circuit board **21** can then be soldered using conventional techniques such as flows soldering.

The circuit board **21** may be assembled so that it is adjacent to a metal panel **64** (FIG. **1**) which may be designed with openings through which sleeves **16** and threaded barrel **12**A are inserted. The panel openings may have flat portions that match the flats **12**B on threaded barrels **12**A.

An end user can use the illustrated connector by attaching a mating connector (for example, an unillustrated BNC connector) that has a center pin that fits between the fingers **22** of connecting element **20**. This mating connector will also have an outer female shell that fits around metal sleeve **16** and locks onto stubs **16**A.

High frequency signals can be conveyed through the illustrated connector. Shielded coaxial cables **34** will have an impedance that matches the impedance of devices attached to the connector to avoid reflections and losses. Cables **34** will maintain good transmission characteristics including low EMI that will not be appreciably degraded by the cable positioning or by the fact that the cables make sharp turns. In particular, the lower cable **34** of FIG. **1** will make a tight pigtail turn, but this tight turn will not significantly degrade the cable's performance.

In some instances it will be desirable to color-code shell **12** so a user can quickly identify different connectors. Still, in some cases the connector assembly of FIG. **1** will be installed with an incorrectly colored shell **12**. Nevertheless, shell **12** can be pushed off metal housing **10** by prying the sides of the shell clear of locking stub **97**. The slots **66** will provide clearance so that pins **52** and **54** and stake **19** will not prevent removal of shell **12**. The replacement shell can be installed simply by slipping it over housing **10** and locking the shell on stubs **97**.

It will be appreciated that metal housing **10** need hot be fitted with shielded cables and instead, simple insulated (or uninsulated) wires can be routed from cavity **30** of element **20** through tunnel **61** and into the barrels **50** of the contact element. In such designs care must be taken to bend the wire with a radius of curvature that avoids losses, radiation, and reflection, but this requirement may not be very demanding in low-frequency applications.

It will also be appreciated that metal housing **10** need not be oriented as shown in FIG. **1** but may instead use leads that leave tunnel **61** without bending so that sleeves **16** are perpendicular to circuit board **21** as with the embodiment of FIG. **13**.

It will further be appreciated that the connector assembly of FIG. **1** can be mated with an identical assembly by using the insert **104** of FIG. **9**. Having a central plate, insert **104** engages a relatively wide region to prevent rocking of the adjacent connector assemblies.

It will be appreciated that various modifications may be implemented with respect to the above described, preferred embodiments. While the illustrated metal housings are cast to provide a pair of connectors, other embodiments may provide more connectors or just a single connector. While external connectors are secured to the illustrated connectors by stubs on the metal sleeves, other connectors may be secured by threading, bayonet fittings, force fitting, etc. The illustrated insulating shell is optional as is the capacitive element, metal backplate, grounding wire etc. The connectors can be mounted on printed circuit boards or other circuit boards in which the connections may be made by wire wrapping, screw terminals, by receiving a pin previously mounted on the circuit board into sockets on the connector assembly, etc. Also, the size, shape and other dimensions of the connector can be varied depending on the desired strength, power rating, frequency rating, etc.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A connector assembly comprising:

a casing including a metallic housing and adapted for mounting on a circuit board, said metallic housing having at least one receptacle;

at least one connecting element mounted at said at least one receptacle;

an interconnect attached to said casing and having a plurality of contact elements adapted to contact the circuit board;

a shielded cable connected between said connecting element and said interconnect, said shielded cable having a central lead and a coaxial shield both separately connected to corresponding ones of said contact elements; and

an annular clip for engaging said receptacle and holding said connecting element in place therein.

2. A connector assembly according to claim **1** wherein said shielded cable is rated to carry signals at over 2 GHz.

3. A connector assembly according to claim **1** wherein said annular clip encircles said cable and connects said coaxial shield to said metallic housing proximate said receptacle.

4. A connector assembly according to claim **1** wherein said at least one receptacle comprises a plurality of receptacles, said at least one connecting element comprising a plurality of conductive elements each in a corresponding one of said receptacles.

5. A connector assembly according to claim **4** wherein said metallic housing has said receptacles on one side and on the opposite side has a recess that contains said shielded cable, said metallic housing having a metallic backplate for covering said recess.

6. A connector assembly according to claim **4** wherein said shielded cable comprises a plurality of shielded cabling lines, one for each of said receptacles, each of said cabling lines (a) being rated to carry signals at over 2 GHz, and (b) having a central lead and a coaxial shield both separately connected to corresponding ones of said contact elements.

7. A connector assembly according to claim **1** wherein said receptacle comprises a metal sleeve surrounding said at least one connecting element.

8. A connector assembly according to claim **7** comprising:

an insulating collar fastened around a distal end of said connecting element.

9. A connector assembly according to claim **1** wherein said interconnect comprises a carrier with openings sized to hold said contact elements, said metallic housing having a hollow for holding said carrier.

10. A connector assembly according to claim **1** comprising:

an insulating shell sized to fit around said metallic housing.

11. A connector assembly according to claim **10** wherein said shell is slidably removable from said metallic housing.

12. A connector assembly according to claim **10** wherein said shell is slidably removable from said metallic housing after said contact elements are attached to the circuit board.

13. A connector assembly according to claim **10** wherein said shell is slidably removable from said metallic housing,

and wherein said shell has at least one subjacent slot giving said contact elements clearance when said shell is being removed.

14. A connector assembly according to claim **1** wherein said casing has a dovetail slot, said connector assembly comprising:

an insert having on opposite sides a dovetail ridge sized to slide into said dovetail slot, so that by means of said dovetail ridges on said insert said casing can be attached to a similar casing with a similar dovetail slot.

15. A connector assembly according to claim **14** wherein said insert has a center plate with said dovetail ridges projecting from opposite sides of said center plate.

16. A connector assembly comprising:

a casing including a metallic housing and adapted for mounting on a circuit board, said metallic housing having a plurality of receptacles;

a plurality of connecting elements each mounted in a corresponding one of said receptacles;

an interconnect attached to said casing and having a plurality of contact elements adapted to contact the circuit board; and

a plurality of shielded cables, one for each of said receptacles, connected between said plurality of connecting element and said interconnect, each of said plurality of shielded cables (a) being rated to carry signals at over 2 GHz, and (b) having a central lead and a coaxial shield both separately connected to corresponding ones of said contact elements, said shield of each of said cables being connected to said metallic housing proximate said receptacles.

17. A connector assembly according to claim **16** wherein said metallic housing has an external grounding tab adapted to attach to the circuit board.

18. A connector assembly comprising:

a casing including a metallic housing and adapted for mounting on a circuit board, said metallic housing having a plurality receptacles, said metallic housing having a grounding hole for receiving a ground line with sufficient clearance inside said casing to reach said interconnects;

a plurality of connecting elements each mounted in a corresponding one of said receptacles:

an interconnect attached to said casing and having a plurality of contact elements adapted to contact the circuit board; and

a plurality of shielded cables connected between said connecting elements and said interconnect.

19. A connector assembly comprising:

a casing including a metallic housing and adapted for mounting on a circuit board, said metallic housing having at least one receptacle;

at least one connecting element mounted at said at least one receptacle, said receptacle comprising a metal sleeve surrounding said at least one connecting element;

an insulating collar fastened around a distal end of said connecting element;

an insulating knob fitted around a proximal end of said connecting element;

an annular clip for engaging said receptacle and holding said insulating knob in place therein;

an interconnect attached to said casing and having a plurality of contact elements adapted to contact the circuit board; and

a shielded cable connected between said connecting element and said interconnect.

20. A connector assembly comprising:

a casing including a metallic housing and adapted for mounting on a circuit board, said metallic housing having at least one receptacle;

at least one connecting element mounted at said at least one receptacle, said receptacle comprising a metal sleeve surrounding said at least one connecting element;

an insulating shell sized to fit around said metallic housing, said shell having a threaded barrel sized to encompass at least a portion of said metal sleeve;

an interconnect attached to said casing and having a plurality of contact elements adapted to contact the circuit board; and

a shielded cable connected between said connecting element and said interconnect.

21. A connector assembly according to claim **20** comprising:

a capacitive element, said shell having an aperture sized to hold said capacitive element; and

a metal structure for holding said capacitive element in said aperture against said metallic housing, said structure extending to a position adjacent said threaded barrel, so that the connector assembly can be mounted on a conductive panel that is then capacitively coupled to said metallic housing.

22. A connector assembly method employing a plurality of variously colored insulating shells and a metallic housing having a receptacle and contact elements, said shells having an aperture, the method comprising the steps of:

bringing the metallic housing to the vicinity of a circuit board;

selecting one of the variously colored insulating shells and fitting it around the metallic housing;

connecting the contact elements to the circuit boards;

installing a capacitive element in the aperture of the shell to contact said metallic housing;

attaching a conductive element that reaches from the capacitive element to a position adjacent the receptacle; and

attaching the receptacle of the metallic housing at an opening in a metal panel to make continuity from it through said conductive element to said capacitive element.

23. A connector assembly method according to claim **22** comprising the step of:

sliding the selected one of said variously colored insulating shells off said metallic housing; and

selecting another one of the variously colored insulating shells and fitting it around the metallic housing while installed on the circuit board.

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